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Variation in the Rate of Infant Mortality in the United States Birth Registration Area

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VARIATION IN THE RATE OF INFANT MORTALITY IN THE UNITED STATES BIRTH REGISTRATION AREA[1]

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Until recently it has been impossible to discuss on any accurate or satisfactory basis the infant mortality of any considerable portion of the United States. This difficulty has arisen from the fact that except in a few localities, notably some of the New England States, there has been in the past no adequate system of birth registration. The most accurate practical method of stating the force of infant mortality is to relate the number of deaths of infants under one year of age in a given time unit to the number born in the same time unit. Consequently, one needs accurate birth statistics before infant mortality can be adequately discussed.

It is a matter of great satisfaction to everyone interested in the subject of infant mortality that at last there is well established a Birth Registration Area for the United States, and four annual reports on Birth Statistics of this area have been issued to date by the Census Bureau. We are well embarked now on the policy of adequate birth statistics for the country and unquestionably within a comparatively few years the Birth Registration Area will cover the major portion of the country as the Death Registration Area now does. In the short period since the Birth Registration Area has been established its growth in extent has been gratifyingly rapid. The first report on birth statistics for the year 1915 comprised data from an area including approximately 31 per cent of the population of the country. The 1918 birth statistics report gives data from an area including 53 per cent of the population. This furnishes a sufficient volume of material so that one may begin the mathematical analysis of some of the problems of infant mortality with some assurance of reaching valid conclusions.

[1] Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, Johns Hopkins University, No. 18. This paper, which is a preliminary and condensed abstract of a much more detailed investigation of the subject, shortly to be published elsewhere.

The purpose of the present paper is a modest one. It aims simply to present briefly some of the facts of variation in rate of infant mortality in different geographic or demographic units of the population. The first step in the solution of any problem is obviously a clear definition of the problem itself. We shall see, as we pass from city to city, town to town, or rural county to rural county, that the rate of infant mortality varies greatly. In a hypothetical commonwealth where the most perfect administrative control over infant mortality possible or conceivable had been attained, this variation would largely disappear, the only residue of diversity between communities in respect of infant mortality being such as arose purely by the operation of chance, that is, from random sampling, or from uncontrollable environmental factors, such as climate or soil. Now, with the actually existing condition of variation between different communities in respect of infant mortality, it is obvious that there must be particulate and presumably determinable reasons for each particular difference which exists. Operating on a basis largely of empiricism and *a priori* reasoning, efforts to reduce infant mortality have in the past been attended with considerable success. Also, with the advance of general sanitation the death rate under one year of age has fallen enormously. Greenwood [3] quotes some interesting figures on the point from Farr, which we may well reproduce here to show how enormous has been the improvement.

Period	1730-49	1750-69	1770-89	1790-1809	1810-29
Percentage Deaths under 5 years....	74.5	63.0	51.5	41.3	31.8

But after such a decline as these figures indicate the continuation of the business offers a difficult problem to the administrative official, whose procedures are grounded essentially only on the two pedestals of what he thinks *has* worked in the past and what he believes logically *ought* to work. The easy part of the conflict has happened and is in the past. To continue the good fight with the same relative measure of success, one presently must needs know more precisely than is now known the pattern of the causal nexus which controls and determines the rate of infant mortality. And it is *real* knowledge, not *a priori* logic, that is wanted. Let a

[3] Greenwood, M. Infant mortality and its administrative control. Eugenics Rev. Oct. 1912, pp. (of reprint) 1-23.

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single example illustrate. It has been maintained that excessive infant mortality is primarily the resultant of the so-called "degrading influences" of poverty, and such a contention stirs a warmly sentimental feeling of agreement in the minds of the well-meaning public zealous to do good. This relationship obviously *ought* to be true, therefore to a too-common type of mind it must be and is true. But Greenwood and Brown[3] in what may fairly be regarded the most thoroughly sound, critical and penetrating contribution which has yet been made to the problem of infant mortality are unable "to demonstrate any unambiguous association between poverty . . . and the death rate of infants."

The plain fact is that before control or ameliorative measures can be applied with the maximum of efficient economy to the general public health problem of infant mortality we must know a great deal more than we now do about the factors which induce spatial and temporal differences in the rate of that mortality. But first we must get an adequate conception of the magnitude and character of the differences themselves. Let us, therefore, turn to the examination of the facts regarding variation in infant mortality in the United States Birth Registration Area.

Variation Data

In this work we have studied the variation in the rate of infant mortality (deaths per thousand births) for the following groups:

1. Total population in cities of population of 25,000 or over in 1910.
2. Total population in cities of under 25,000 population in 1910.
3. Total population in rural counties of registration states.
4. White population in cities of population of 25,000 or over in 1910.
5. White population in cities of under 25,000 population.
6. White population in rural counties of registration states.
7. Colored population in cities of population of 25,000 or over in 1910.
8. Colored population in cities of under 25,000 population.
9. Colored population in rural counties of registration states.

In order to make possible a better appreciation of the nature of the frequency distributions Figure 1 has been prepared. This shows for the year 1918 the frequency polygons for the total popu-

[3] Greenwood, M. and Brown, J. W. An examination of some factors influencing the rate of infant mortality. Jour. Hyg. Vol. XII, pp. 5-45, 1912.

lation of (a) cities of 25,000 and over, (b) cities of under 25,000, and (c) rural counties.

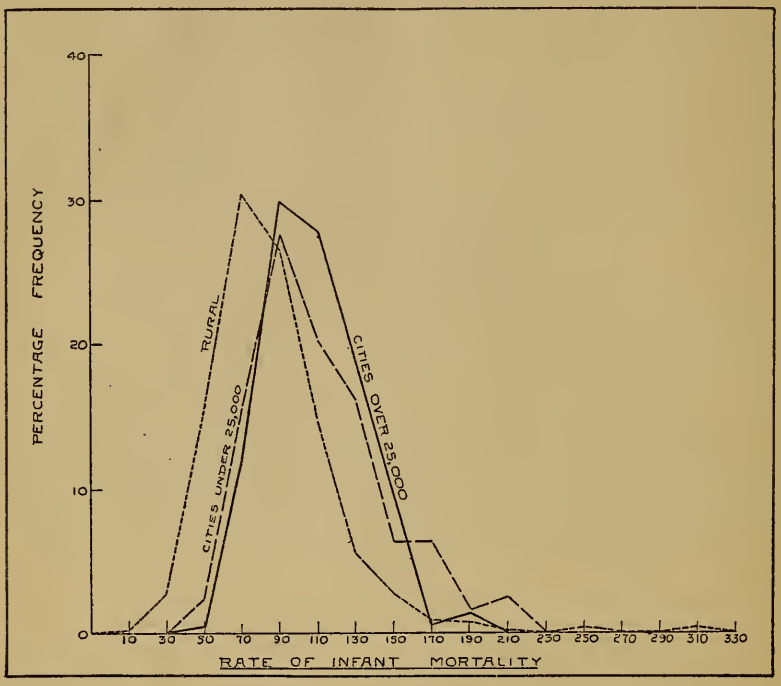

Fig. 1. Frequency polygons showing variation in the rate of infant mortality in 1918 for the total population of (a) cities of 25,000 and over, (b) cities of under 25,000, and (c) rural counties.

This diagram is fairly representative of all the distributions.

The most striking immediately observable feature of these distributions is the great range of variation which they exhibit. For example, in 1918 the 236 cities of under 25,000 inhabitants showed infant mortality rates ranging all the way from the class 40-59 deaths per thousand births to the class 300-319 deaths per thousand births. The range of variation is even greater than this in the case of the distributions for the colored population. These extraordinarily large ranges of variation demonstrate perhaps more clearly than could be done in any other way the opportunity which exists for effective administrative control and reduction of infant mortality. If there are communities, as there are in plenty, show-

ing infant mortality rates under 100 deaths per thousand births it suggests at once that it is possible if the right measures are systematically and effectively applied to reduce the infant mortality in those other communities showing very high rates to something like the level of these at present more fortunate communities.

TABLE I.

Constants of variation in rate of infant mortality (deaths under 1 per 1,000 births)

Group	Mean[2]	Median[2]	Standard deviation[2]	Skewness
Cities over 25,000[1], Total, 1915	104.49 ± 1.78	102.76	26.14 ± 1.26	+.3148
" " " " 1916	102.53 ± 1.67	103.24	24.69 ± 1.18	−.0786
" " " " 1917	99.58 ± 1.32	98.00	23.45 ± .93	+.2455
" " " " 1918	107.78 ± 1.41	105.50	25.07 ± 1.00	+.3237
Cities under 25,000[1], Total, 1915	100.98 ± 1.68	97.95	30.81 ± 1.18	+.1934
" " " " 1916	104.23 ± 1.75	101.03	32.38 ± 1.24	+.2217
" " " " 1917	99.24 ± 1.32	94.74	29.94 ± .93	+.4840
" " " " 1918	111.61 ± 1.66	104.17	37.78 ± 1.17	+.5625
Rural counties, Total, 1915	83.07 ± .85	79.54	23.95 ± .60	+.3204
" " " 1916	85.28 ± .90	82.15	25.94 ± .63	+.3536
" " " 1917	82.01 ± .52	78.96	25.71 ± .37	+.2833
" " " 1918	84.43 ± .57	80.97	28.40 ± .40	+.4328
Cities over 25,000[1], White, 1917	92.22 ± 2.02	92.14	15.60 ± 1.43	....
" " " " 1918	102.59 ± 2.00	99.23	15.42 ± 1.42	....
Cities under 25,000[1], White, 1917	98.46 ± 2.75	97.50	20.82 ± 1.95	....
" " " " 1918	114.62 ± 4.17	113.33	31.49 ± 2.95	....
Rural counties, White, 1917	86.21 ± 1.07	84.24	24.15 ± .76	+.1799
" " " 1918	85.90 ± 1.27	83.75	28.90 ± .90	+.2802
Cities over 25,000[1], Colored, 1917	202.59 ± 8.88	194.00	68.45 ± 6.28	....
" " " " 1918	216.67 ± 11.15	214.00	85.87 ± 7.88	....
Cities under 25,000[1], Colored, 1917	213.08 ± 9.92	228.00	74.96 ± 7.01	....
" " " " 1918	217.69 ± 11.46	225.00	86.65 ± 8.10	....
Rural counties, Colored, 1917	134.76 ± 2.55	127.25	57.37 ± 1.80	+.4984
" " " 1918	147.26 ± 2.92	134.59	66.15 ± 2.06	+.5819

[1] In 1910.
[2] In concrete units, *i. e.*, rate of deaths under 1 per 1,000 births.

In Table I are presented the chief physical constants[4] of the distributions of variation in infant mortality. These constants have been determined by the method of moments from the original raw data.[5]

[4] For a very brief and summarized introduction to the modern mathematical treatment of frequency curves see Pearson, K., "Tables for Statisticians and Biometricians," 1914, pp. lx to lxx. References to the basic literature on the subject will be found there.

[5] I am greatly indebted to my assistant, Mrs. Charmian Howell, for aid in the arithmetical work of this paper.

The constants tabled are:

1. The arithmetic mean.
2. The median. This measures the value above and below which exactly half of the variates occur.
3. The standard deviation. This constant measures in absolute units the degree of "scatter" or variation exhibited by the distribution.
4. The skewness. This constant measures the degree of asymmetry of a frequency distribution. If a distribution is perfectly symmetrical on both sides of the mean so that if folded over upon the mean as an axis the two limbs would exactly coincide, the value of the skewness is zero.

From the data presented in Table I. the following points are to be noted:

1. There is no certainly significant decline in the mean value of the rate of infant mortality during the four years covered by these statistics in any of the demographic units considered.

2. In 1918 there was a general tendency towards an increase in the mean rate of mortality over that which obtained in 1917. This increase is unquestionably to be attributed to the influenza epidemic of the autumn and winter of 1918. A careful examination of the rates by months will convince one that the mortality of infants increased very materially during the period of the epidemic. Whether this increased number of deaths was truly to be charged to influenza does not concern us here. The important fact is that the rate of infant mortality markedly increased coincidently with the existence of the epidemic. It is noteworthy that this increase in the infant mortality rate in 1918 is practically confined entirely to the cities. The rural counties, whether for white or colored or total population, show little or no change in 1918 as compared with 1917.

3. There is no unequivocal difference in the mean rates of infant mortality in the larger as compared with the smaller cities. Considering the largest differences in mean rates for total populations in cities of 25,000 and over as compared with cities of under 25,000 there is no difference which is as much as even three times its probable error.

4. The mean rates of infant mortality are notably smaller in the rural than in the urban areas. This fact has, of course, long been well known. The first writer on vital statistics, in the sense in which we now understand that subject, Captain John Graunt,

more than 250 years ago pointed out that rural communities exhibited generally a lower rate of mortality than urban communities. The difference between urban and rural rates of infant mortality is reflected just as clearly in the high absolute rates of the colored population as it is in the lower rates of the white population.

5. The mean rates of infant mortality are, roughly speaking, something like twice as high for the colored population as for the white population in each of the demographic units considered, and at all times. This again is a fact in general well known, but here we have precise figures on the point, with probable errors, which show definitely how tremendously poorer the negro baby's chances of surviving the first year of life are than the white baby's.

6. The cities of over 25,000 exhibit distinctly less variation in respect of infant mortality than do either the smaller cities (under 25,000) or the rural counties. The smaller cities and the rural counties exhibit about the same degree of variation relative to their means, but absolutely, in terms of standard deviation, the rural counties show less variability than the cities under 25,000. The colored distributions exhibit a much higher degree of variation in respect of infant mortality however measured, whether absolute or relative, than do the white populations. In general, it may fairly be assumed that the greater the variation exhibited by a given class of the community in respect of infant mortality, the greater the chance of effective control and reduction of the average infant mortality by administrative measures. There can be no question that there is no field which offers so great opportunities in this direction as the colored population.

7. The skewness is seen to be positive in sign in every case but one. In that case (1916, cities over 25,000 total) the skewness is not significant in comparison with its probable error. With this exception the curves tend to tail off more gradually and farther towards the right end than towards the left end of the range. In other words, the rate of infant mortality in these different American demographic units tends generally to distribute itself in a substantially unsymmetrical fashion about the mean, extremely high rates occurring more frequently than correspondingly low rates. This fact might perhaps be taken to indicate that the task confronting the administrative control of infant mortality in the United States, and

yet to be accomplished, is even greater than what has already been accomplished in the past, great and worthy of commendation as that is.

Data on the Limitations to Administrative Control of Infant Mortality.

We have seen that there is a high degree of variation in the rate of infant mortality as we pass from community to community. Some communities have infant mortality rates several times higher than those prevailing in other communities of the same size. This creates the presumption at once that proper administrative activity might reduce the rates of these abnormally high communities to a level commensurate with those found in the lower group. It is the purpose of this section of the paper to examine this presumption critically.

At the outstart it is evident that there are some causes of infant mortality which are, in their very nature, beyond hope of effective practical human control. Thus, children born with marked congenital hydrocephalus will presently die, in spite of anything the health officer can do, no matter how active and intelligent he may be. There are other causes of death falling in essentially the same category in this respect.

Not as any final or dogmatic settlement of the matter, but rather as a tentative first approximation made for the purpose of seeing whether any suggestive lead may appear, I have ventured to attempt to classify the principal causes of mortality in the first year of life into two groups. The first of these groups aims to include those important causes of infant mortality which are either (a) actually now effectively controlled by the efforts of health officials, either directly, or indirectly through general sanitary and hygienic improvements, or (b) are obviously capable theoretically of control and amelioration if sufficient pains be taken. The second group aims to include those causes of infant deaths which are either (a) in the nature of the case, out of the range of effective practical, *direct* control or amelioration, or (b) are not in fact now controlled in any appreciable degree. Let us see what such a classification, to a first approximation, looks like.

Tentative Classification of Principal Causes of Infant Mortality.

A. Causes of death actually now well controlled, or capable theoretically of direct control in greater or less degree:	B. Causes of death not controlled
Measles	Tuberculosis of the lungs
Scarlet fever	Tuberculous meningitis
Whooping cough	Other forms of tuberculosis
Diphtheria and croup	Syphilis
Dysentery	Organic diseases of the heart
Erysipelas	Malformations
Tetanus	Premature birth
Meningitis	Congenital debility
Convulsions	Injuries at birth
Acute bronchitis	
Pneumonia	
Bronchopneumonia	
Diseases of the stomach	
Diarrhea and enteritis	
External causes	

One realizes that it is a bold thing even to set down such a classification as the above. It is certain to stir up the rancor of extremists in both directions. But extremists are nearly always wrong. Calm and unprejudiced persons will admit that some such classification as that here attempted is possible. Perhaps some further discussion of this classification may make clearer its point of view, and may win at least that measure of agreement with it which will at least permit the consideration of the discussion of its consequences which follows.

Taking column A first, presumably no competent health official would deny that the first diseases in the list (scarlet fever, whooping cough, diphtheria and croup, and dysentery) have been, can be, and are in greater or less degree effectively controlled in respect both of their incidence and their mortality. With this same group clearly belongs also diarrhea and enteritis, and convulsions, on the justifiable assumption that in the vast majority of cases convulsions in infants are consequent upon violent enteric infections, which clearly belong in the controllable class. Diseases of the stomach, as causes of death *under one year of age,* again in the vast majority of cases undoubtedly mean infection—filth diseases in short—which come in the same category, so far as concerns control, as diarrhea and enteritis. Regarding the rest of the diseases in the A group (erysipelas, tetanus, meningitis, acute bronchitis,

pneumonia, bronchopneumonia, and external causes) the point of view of which led to their inclusion here is as follows: If the environmental conditions surrounding the infant in the community and in the home, and the care given it, were made as favorable as they might be made, and actually are in the homes of the hygienically intelligent well-to-do, the death rate from each of these causes would be enormously reduced relatively in comparison with what it actually is. As a matter of fact visiting child welfare nurses are doing a mighty work in just this direction in many communities. They teach parents how to care for their infants, protect them from these infections, and nurse them to a non-fatal issue in many cases if they do get infected.[6]

Now for the B column. The first three items are the various forms of tuberculosis. The fanatic will no doubt promptly assert that nothing is so easily and readily controllable as these. But let us make haste slowly and remember certain things: First, that we are here talking about *deaths* under one year of age, that is *fatal* tuberculosis in the first months of life; and second, that our classification premises, in specific and stated terms, *direct control,* that is control through agencies acting directly upon the infant or his environment. *Theoretically* it is possible to reduce materially the mortality under 1 from tuberculosis. If every child born to tuberculous parents was instantly and ruthlessly removed from the home from the moment of birth, and reared in an environment where no contact with tubercle bacilli was possible, unquestionably enormously fewer infants would develop tuberculosis in the first year of life than now do. A recent paper by Bernard and Debrè[7] furnished an instructive example, showing in a single case how a child removed at 1½ months from its tuberculous mother, threw off completely its own tuberculosis. But *practically* it is perfectly clear that neither in the past has there been, nor in the present is there, nor probably for some time in the future will there be rigid isolation of offspring from tuberculous parents to an

[6] No one who knows at first hand what child-welfare public health nursing is actually accomplishing in these directions will question the putting of these diseases in the controllable column. Their mortality rate can be materially reduced if communities will take the trouble to go intelligently about it.

[7] Bernard L., and Debre, R. Bull. Soc. Med. des Hosp. T. 44, p. 1658. 1920. Rev. in Jour. Am. Med. Assoc. March 19, 1921, p. 824. See also paper in the present volume of these Transactions, on "Prevalence and Management of Tuberculosis in Infancy," by T. C. Hempelmann, p.

extent or degree sufficient to influence the infant mortality from tuberculosis, in the entire Registration Area of the United States, by as much as one unit of the death rate. The mortality from tuberculosis under 1 year of age has to be sure declined during the past 40 or 50 years but no more rapidly than the general curve of tubercular mortality at all ages. But many persons fail to find any evidence that control measures have had anything to do in bringing down the general tuberculosis death rate. In this connection a recent paper by Given[8] on the influence of administrative or control measures upon the course of tuberculous mortality in general is interesting. He says: "Statistics show us that, in spite of all that has been said and done for the prevention of tuberculosis, our efforts in regard to pulmonary tuberculosis have not been attended with the anticipated success. The decline in mortality from this cause dates from 1838, and has continued steadily ever since down to 1913. Koch's discovery of the tubercle bacillus in 1882 does not appear to have affected it in any way."

I know of no evidence that anything now being done is sensibly influencing the rate of mortality from tuberculosis in infants under 1. Some individual physicians may have been particularly successful with a small number of tuberculous babies under his care. But statistically it means little in the toll of 2,501 deaths under 1 which tuberculosis is recorded to have taken in the Registration Area of the United States in 1918. Actually if the truth were known the total would be much larger even than this.

About fatal congenital organic diseases of the heart, congenital malformations grave enough to be fatal in the first year of life, and fatal congenital debility there will probably be no dispute. The mortality from fatal congenital syphilis is again, like tuberculosis, *theoretically* controllable.[9] But *practically* and in fact, is it controlled? The writer feels extremely doubtful about it.

Regarding premature birth, and injuries at birth, much the same reasoning applies, but with the additional consideration that presumably intelligent prenatal education of the mothers and improvement of prenatal environmental conditions would reduce

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[8] Given, D. H. C. Some deductions from the statistics on the prevention of pulmonary tuberculosis. Bull. Med. Jour. Feb. 12, 1921, pp. 225-226.

[9] Cf. Jeans, P. C. Syphilis and Infant Mortality. Trans. Am. Assoc. for Study and Prev. Inf. Mortality. Vol. IX, p. 155.

these mortality rates in some unknown, but probably not large degree. Actually, however, there is no tangible evidence that these causes of death are in effect administratively controlled in any appreciable degree in this country at this time.

Finally it should be said that one occasionally important cause of infant mortality is omitted entirely from the classification. This is influenza. The reason for the omission is simply that the statistical discussion which follows is based upon 1918 mortality figures

TABLE II—Showing the deaths under one year of age per 1,000 living births for (A) controllable, and (B) non-controlled causes of death in certain American cities of 100,000 population or over in 1910.

City	Births in 1918	Deaths under one year				
		A. From causes controllable in some degree	A. Rate of controllable deaths	B. From causes not controlled	B. Rate of not controlled deaths	Rate per 1,000 births from all causes
Bridgeport	4,910	226	46	224	46	100
New Haven	4,869	190	39	200	41	90
Washington	8,162	399	49	450	55	112
Indianapolis	6,196	270	44	269	44	93
Louisville	4,368	239	55	210	48	112
Baltimore	15,143	1,225	81	847	56	149
Boston	20,062	1,092	54	984	49	115
Cambridge	2,672	144	54	111	42	107
Fall River	3,646	403	111	183	50	180
Lowell	3,286	302	92	180	55	159
Worcester	5,238	212	40	248	47	97
Detroit	27,036	1,296	48	1,199	44	100
Grand Rapids	2,836	110	39	119	42	86
Minneapolis	8,704	198	23	358	41	73
St. Paul	5,155	160	31	135	26	87
Albany	2,158	96	45	122	57	115
Buffalo	13,989	866	62	653	47	121
Bronx Borough	16,763	496	30	669	40	75
Brooklyn Borough	49,515	2,232	45	1,889	38	90
Manhattan Borough	59,227	2,855	48	2,456	41	97
Queens Borough	9,467	389	41	417	44	93
Richmond Borough	2,677	113	42	139	52	106
Rochester	6,855	283	41	276	40	92
Syracuse	4,352	265	61	206	47	119
Cincinnati	7,913	326	41	404	51	104
Cleveland	20,699	963	47	790	38	98
Columbus	4,464	163	37	255	57	101
Dayton	3,282	109	33	143	44	87
Toledo	5,524	186	34	270	49	94
Philadelphia	43,408	2,876	66	1,993	46	124
Pittsburgh	15,875	1,179	74	805	51	139
Scranton	3,139	263	84	141	45	141
Providence	6,384	342	54	352	55	123
Richmond, Va.	3,840	199	52	285	74	147
Seattle	5,910	93	16	218	37	61
Spokane	2,194	55	25	90	41	77
Milwaukee	11,090	574	52	488	44	106

and inasmuch as that was a year in which the influenza mortality was abnormally heavy owing to the epidemic it was thought that it would be unfair to the general relationships exhibited to include this epidemic mortality. Presumably normal endemic influenza should be in the A group, on the same reasoning as the pneumonias.

With so much of explanation as to the point of view of this classification let us examine some of its statistical consequences. These consequences I have tested in a preliminary way upon the birth and death data for certain large cities and the registration states in 1918. There were found to be 37 large cities included in both Birth and Death Registration Areas in that year, and 20 states. For each of these cities and states the births were taken from 1918 Birth Statistics and the deaths under one year of age according to causes from Table II of the 1918 Mortality Statistics. From these data the rates per thousand living births for all class A and all class B diseases were separately calculated. The results are set forth in Tables II and III.

TABLE III—Showing the deaths under one year of age per 1,000 living births for (A) controllable, and (B) non-controlled causes of death in twenty registration states.

State	Births in 1918	Deaths under one year				
		A. From causes controllable in some degree	A. Rate of controllable deaths	B. From causes not controlled	B. Rate of not controlled deaths	Rate per 1,000 births from all causes
Connecticut	36,971	1,755	47	1,723	47	107
Indiana	64,385	2,482	39	2,526	39	87
Kansas	39,117	1,163	30	1,522	39	80
Kentucky	62,338	2,325	37	2,328	37	93
Maine	16,798	670	40	743	44	101
Maryland	34,113	2,531	74	1,730	51	140
Massachusetts	95,640	5,284	55	4,324	45	113
Michigan	91,011	3,496	38	3,760	41	89
Minnesota	55,941	1,317	24	2,060	37	71
New Hampshire	9,642	451	47	499	52	113
New York	242,155	10,897	45	10,333	43	97
North Carolina	75,525	2,850	38	2,319	31	102
Ohio	124,586	5,029	40	5,206	42	94
Pennsylvania	220,170	14,506	66	10,295	47	129
Rhode Island	15,499	947	61	783	51	126
Utah	14,478	308	21	474	33	64
Vermont	7,507	258	34	343	46	93
Virginia	63,062	2,529	40	2,448	39	103
Washington	25,682	544	21	980	38	69
Wisconsin	60,867	1,854	30	2,334	38	79

In the last column of these tables the gross infant mortality rates from all causes of death have been inserted for comparison and to furnish the basis of certain discussions which will follow. It will be noted that the five boroughs of New York City have been treated as separate cities. This appears to be entirely justifiable, both on grounds of size, and of differentiation, any two of these boroughs being as much differentiated biologically and demographically as, for example, Minneapolis and St. Paul.

The first point which strikes one in examining Tables II and III is that in the group of causes of death subject to our classification (which includes in most cases, as will be seen, something over 90 per cent of all the mortality under one year of age) the controllable and uncontrolled causes are responsible for approximately an equal degree of mortality. In other words, it appears that if any degree of justification attaches to the classification here suggested, the infant mortality beyond present control by administrative measures is by no means a negligible fraction of the total infant mortality. On the contrary, it represents a substantial lower limit sensibly below which the health officer, no matter how zealous and intelligent his activities, may not hope to go at the present time.

If there is a substantial moiety of the existing infant mortality which is uncontrolled by administrative measures and is essentially unaffeected by the present or past application of such measures, we should expect that the rate of mortality represented by this moiety would vary but little from city to city or state to state. As we have seen, the main reason why this part of the total infant mortality is beyond control is because it depends upon fundamental biological factors inherent in the parents and the infants. Clearly if this is so, whatever variation appears in this portion of the total infant mortality rate as we pass from community to community must arise from some combination of two factors; of which the first and less important is pure chance, that is, variation arising from random sampling purely; and of which the second is differing racial and other biological characteristics of the populations of the several communities. We should expect the variation in the death rate from the class B group of causes to show very little variation as compared either with the variation in the rate from class

A causes or in the gross infant mortality rate from all causes. This *a priori* expectation is beautifully realized in the actual statistics.

TABLE IV—Frequency distributions of variation in rates of mortality under one per thousand births for (A) controllable, and (B) non-controlled causes.

Rate	Cities			States		
	A Causes	B Causes	All Causes	A Causes	B Causes	All Causes
15- 24	2	..	..	3	..	..
25- 34	5	1	..	3	2	..
35- 44	9	16	..	7	11	..
45- 54	12	13	..	3	7	..
55- 64	3	6	1	2	..	1
65- 74	2	1	1	2	..	2
75- 84	2	..	2	..	..	2
85- 94	1	..	9	..	..	5
95-104	..	..	7	..	..	4
105-114	1	..	5	..	..	3
115-124	..	..	6	..	..	..
125-134	..	..	..	..	..	2
135-144	..	..	2	..	..	1
145-154	..	..	2	..	..	..
155-164	..	..	1	..	..	..
165-174	..	..	..	..	..	..
175-184	..	..	1	..	..	..
Totals	37	37	37	20	20	20

TABLE V.

Variation constants from the distributions of Table IV.

Group	Mean	Median	Standard deviation
Cities, A, controllable causes	49.46 ± 2.04	47.08	18.37 ± 1.44
Cities, B, non-controlled causes	47.30 ± .90	46.15	8.09 ± .63
Cities, all causes	107.84 ± 2.75	102.86	24.78 ± 1.94
States, A, controllable causes	42.00 ± 2.17	40.71	14.41 ± 1.54
States, B, non-controlled causes	42.50 ± .83	42.27	5.52 ± .59
States, all causes	97.00 ± 3.03	95.00	20.07 ± 2.14

It is seen that the *class B causes of death, which are not practically capable at the present time of administrative control or amelioration, exhibit less than one-half as much variation in the rate of infant mortality for which they are responsible, as we pass from city to city or from state to state, as do the class A causes of death, which are capable of administrative control.* This relation is true however the variation is measured. This is a novel result, of interest from several points of view.

In the first place, the suggestion lies near at hand that if the class A causes of death, which are controllable, show such great variation relatively as they do, it must mark an approximately equal variability in the zeal, intelligence, and efficiency of the administrative health officials of these communities. Anyone at all familiar with the organization of municipal and state health departments in this country will find it extremely interesting to study in detail the entries of Tables II and III noting how the class A (controllable) and the "all causes" rates fluctuate up and down, while the class B (non-controlled) rates stay, with a very few exceptions, so extremely constant. One will observe, with great satisfaction what splendid work is being done in some communities in holding down to a low level the infant death rate from controllable causes. Table II forms a real justification of the faith that is in the public health official of vision. It shows that the infant mortality from controllable causes *can* be kept down to a low level, and is in some communities. In the following cities (17 out of 37) the rate of infant mortality from the controllable causes of class A is actually *lower* than the rate from the non-controlled causes (class B).

New Haven	Cincinnati
Washington	Columbus
Worcester	Dayton
Grand Rapids	Toledo
Minneapolis	Providence
Albany	Richmond
Bronx Borough	Seattle
Queens Borough	Spokane
Richmond Borough	

These cities stand as examples of the fact that a considerable portion of the infant mortality rate can be controlled.

Summary.

This paper is a first biometric survey of the infant mortality statistics of the recently established Birth Registration Area. It is to be regarded as preliminary to certain analytical studies of the problem of infant mortality now in progress in this laboratory. The chief results of the paper are first to set forth and discuss some of the constants of variation in infant mortality in the different demographic units. This variation, which is large in amount, markedly and consistently skew in the positive direction, defines

and throws into high relief the fundamental public health or administrative problem of infant mortality. Why do the communities having rates of infant mortality higher than the average occupy that position? Is it from causes capable of human control, or from causes beyond the possibility of such control? A special preliminary analysis of the data for cities of over 100,000, and the registration states indicates that causes of death capable of administrative control are chiefly responsible for the variation observed in the total infant mortality rate, while those causes of infant deaths which, for fundamental biological reasons, are not sensibly influenced or controlled by administrative measures, are a highly stable and constant factor from community to community, contributing little to the observed variability of the total infant mortality rate. In absolute terms, however, these causes of death not administratively controlled are responsible for roughly 40 per cent of the total infant mortality in the communities discussed.

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